Consistency between surface emissions at different scales for use in regional and global forecasting models

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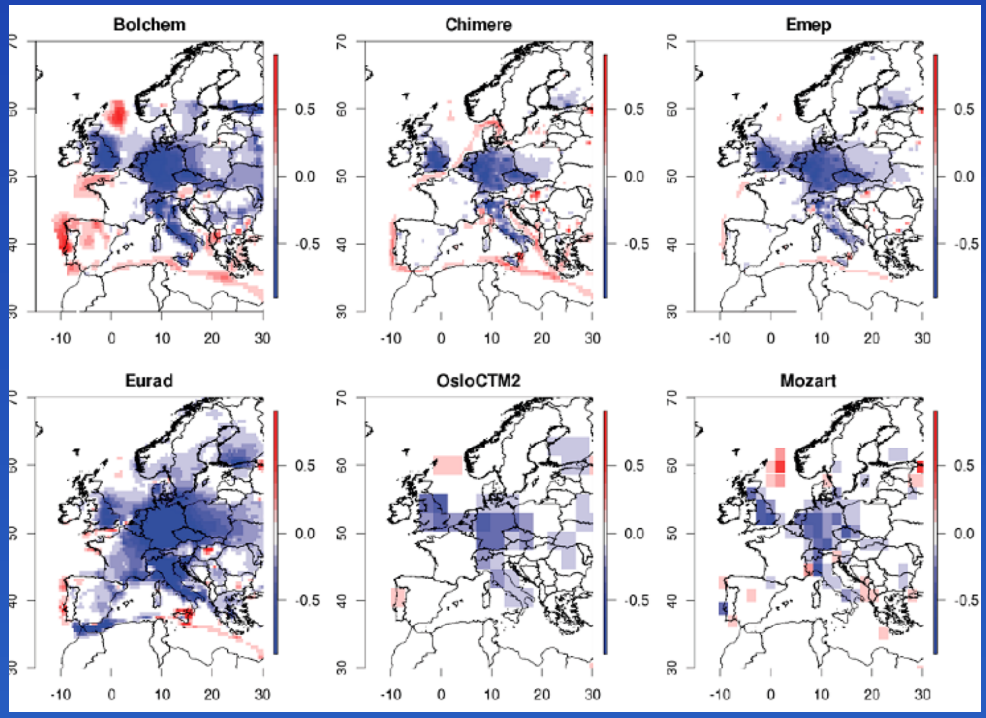
Why do we need to use consistent global/regional emissions?

- Results of global models are used as boundary conditions for regional models

- For projects doing both regional and global forecasts, such as MACC

- When studying trends calculated by global and regional models, we need to be sure that trends in emissions are consistent

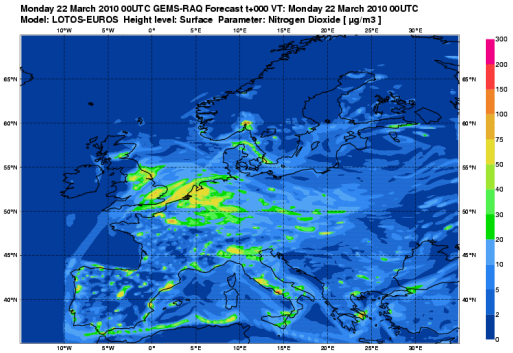


From Colette et al., ACP 2011: 1997-2008 NO2 trends from global/regional models

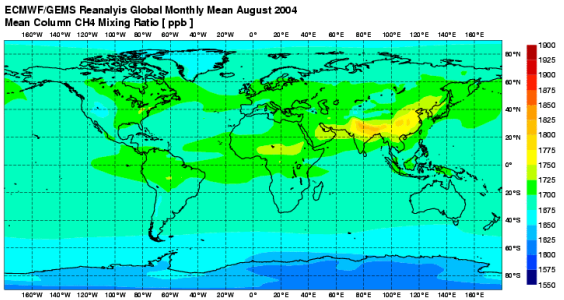
MACC: Monitoring Atmospheric Composition and Climate: http://gmes-atmosphere.eu

MACC: until Dec 2011; MACC-II: since Nov 2011

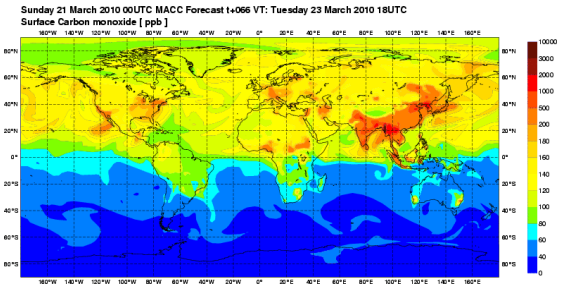
Air quality



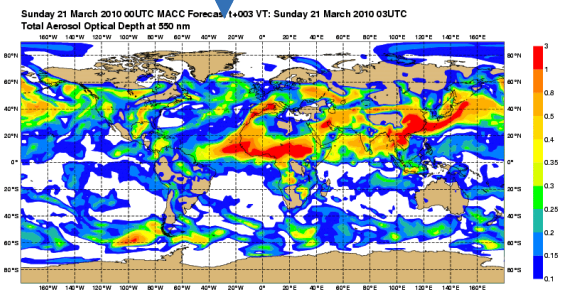
Reanalysis



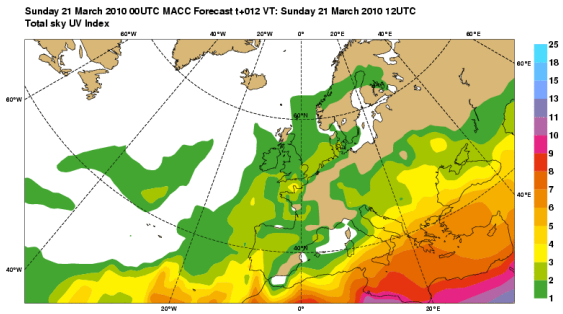
Global Pollution



Aerosol



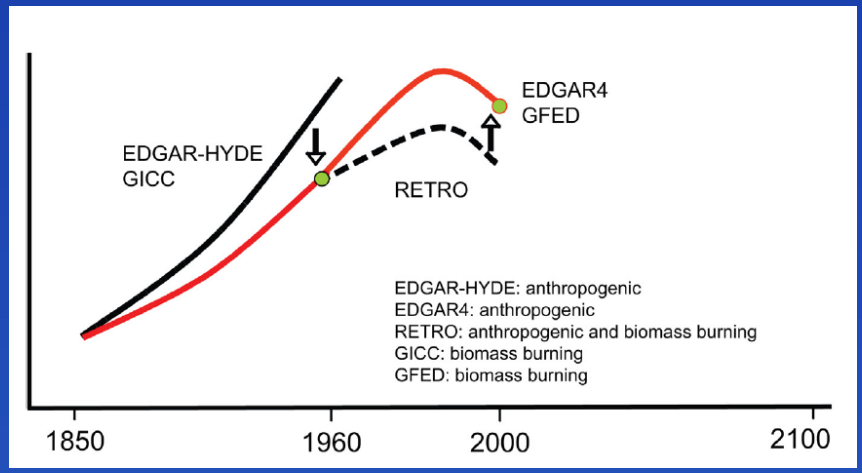
UV index



The ACCMIP emissions developed for the IPCC AR5 report = Consistent long-term emissions dataset [emissions for Atmospheric Chemistry and Climate Modeling Intercomparison Project]

Developed in 2008-2009 by an international group

➔ Developed in support of the IPCC AR5 report
➔ Anthropogenic and biomass burning emissions
➔Period covered: 1850 – 2000
➔Available for each decade
➔ no seasonal variation
➔ 0.5x0.5 degree



➔ Details in Lamarque et al., ACP 2010

MACCity Emissions dataset:
(Emission dataset developed within two EU projects: MACC and CityZen)

After 2000, no global emissions dataset available
➔Use of one of the IPCC future scenarios (RCP 8.5) for 2005, 2010 and 2020.

MACCity anthropogenic emissions:
→ Linear interpolation for 1980-2011 of ACCMIP and RCP8.5 emissions
→ Implementation of seasonal emissions from the RETRO emissions (Schultz et al., 2007)

Are any of these emissions accurate?

➔ A systematic evaluation of surface emissions has started within GEIA (Global Emissions Inventory Activity): geiacenter.org

➔ Open to all people willing to propose new data / analyze results

➔ Start with the 1980-2010 period (extended to 1970-2011)

➔ Only publicly available gridded inventories considered so far

➔ Focus on: CO, NOx, SO2 and BC (current work: CH4, OC, total NMVOCs and NH3)

➔ Evaluate the consistency of emissions in Europe, US, China and India [Canada, South America, Africa, and Oceania are under way]

Up to now: only total anthropogenic emissions

→ Most global inventories use the IPCC sectors
→ Regional inventories developed by regulatory agencies use SNAP or other sectors

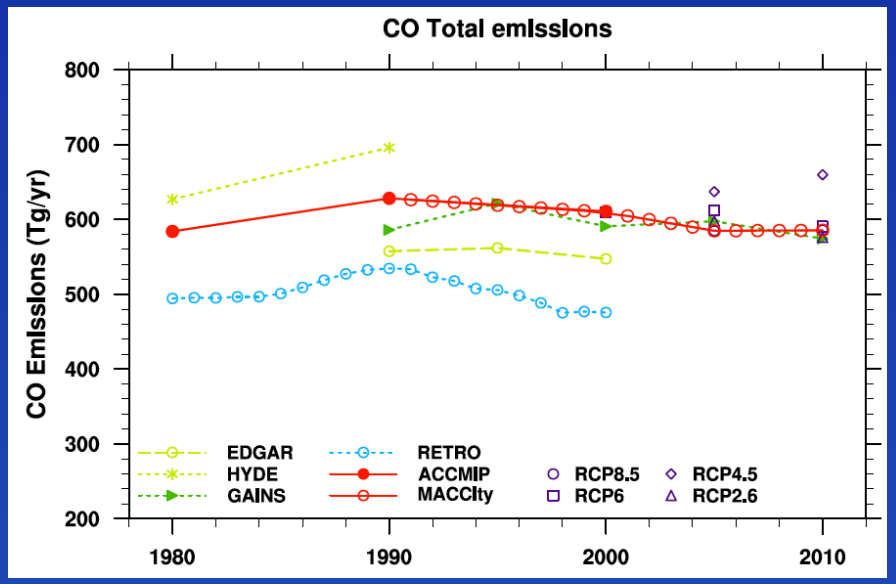
Sector number	Sector name
1	Energy production and distribution
2	Industry (combustion and non-combustion)
3	Land transport
4	Maritime transport
5	Aviation
6	Residential and commercial
7	Solvents
8	Agriculture
9	Agricultural waste burning on fields
10	Waste
11	Open vegetation fires in forests
12	Open vegetation fires in savanna and grasslands
13	Natural emissions

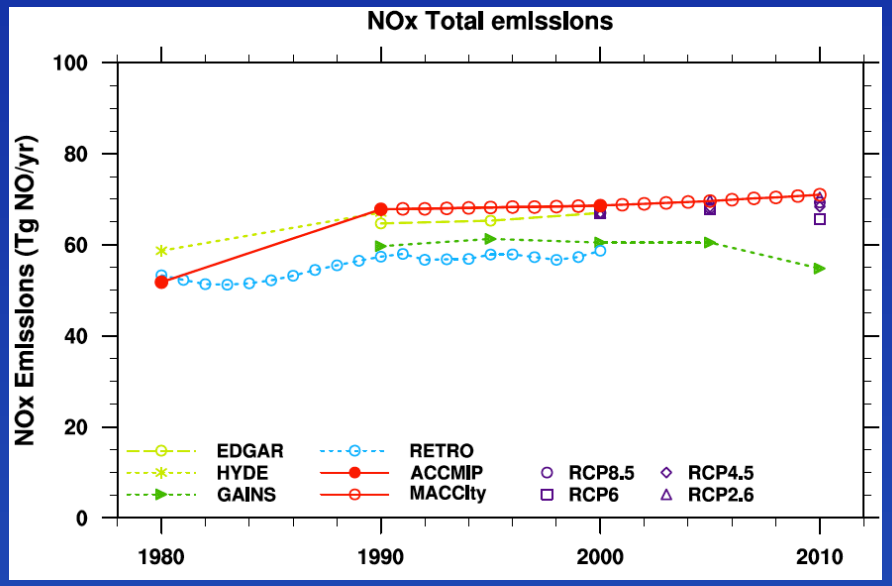
IPCC sectors

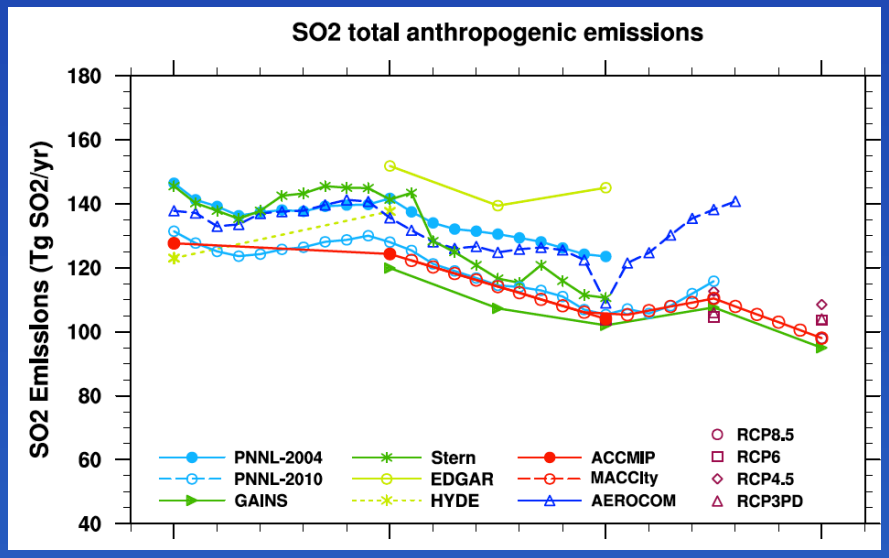
SNAP sectors

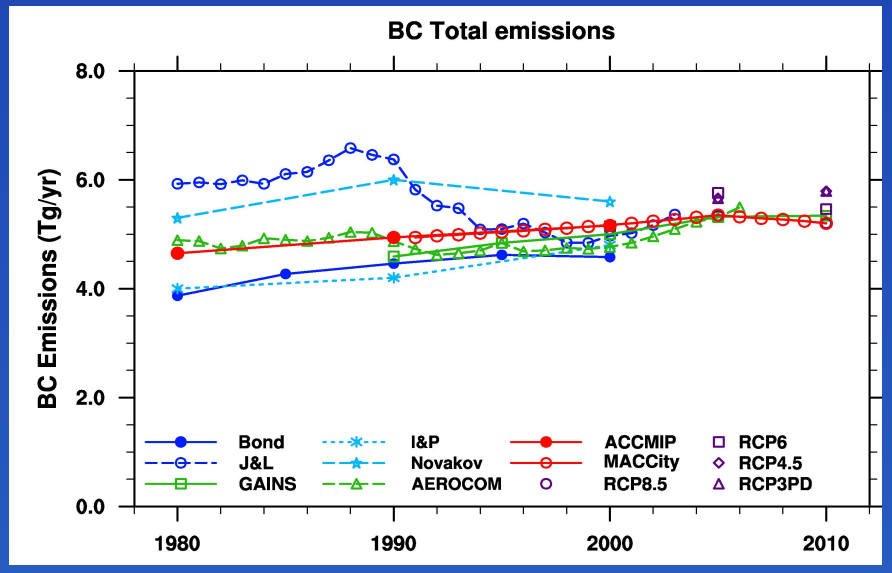
SNAP	Description
1	Public electricity and other energy transformation
2	Small combustion plants
3	Industrial combustion and processes with contact
4	Industrial process emission
5	Fossil fuel production
6	Solvent and product use
7	Road Transport
8	Other (non-road) transport and mobile machinery
9	Waste disposal
10	Agriculture
11*	Nature

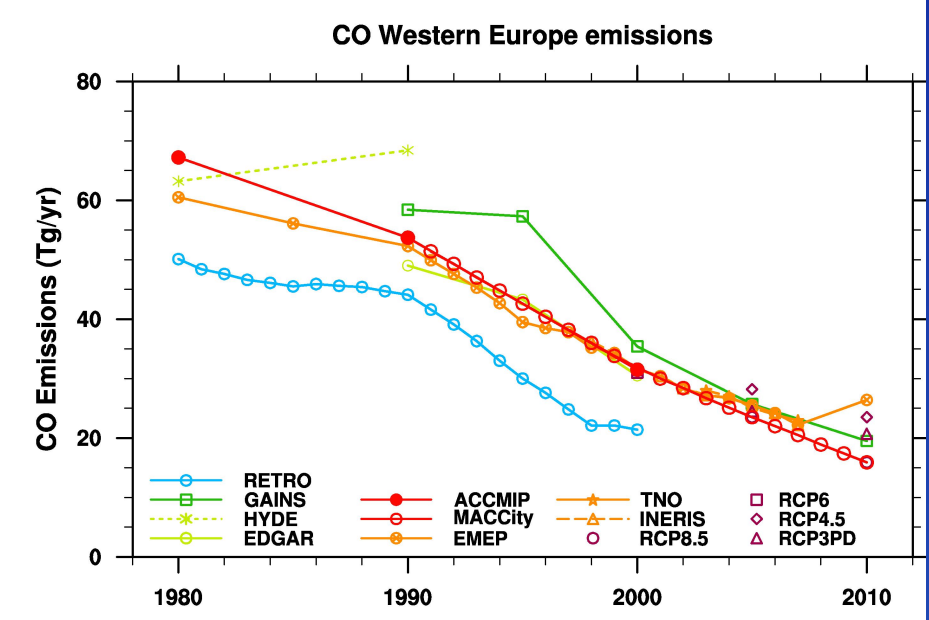
Examples of comparison of anthropogenic emissions

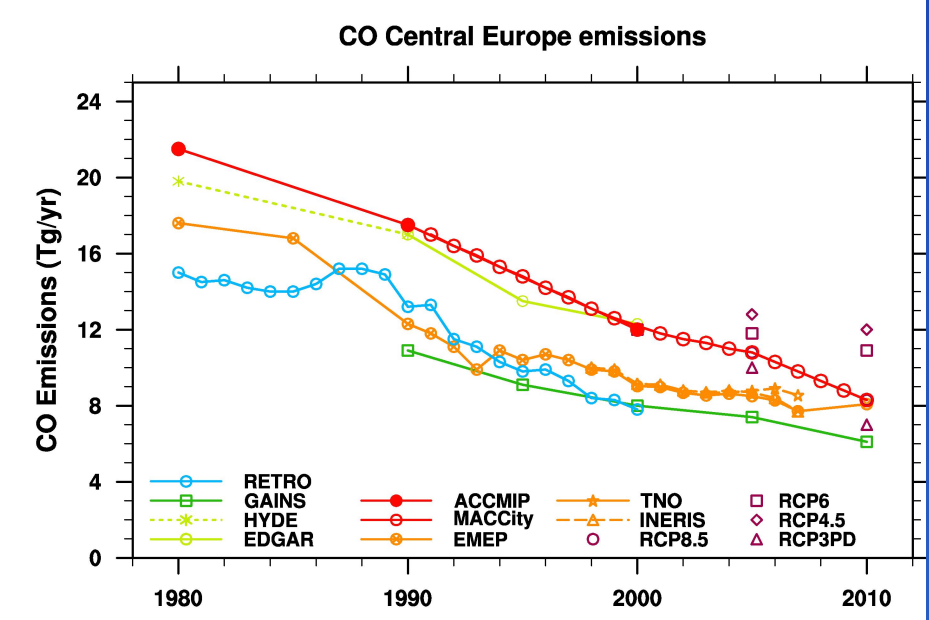








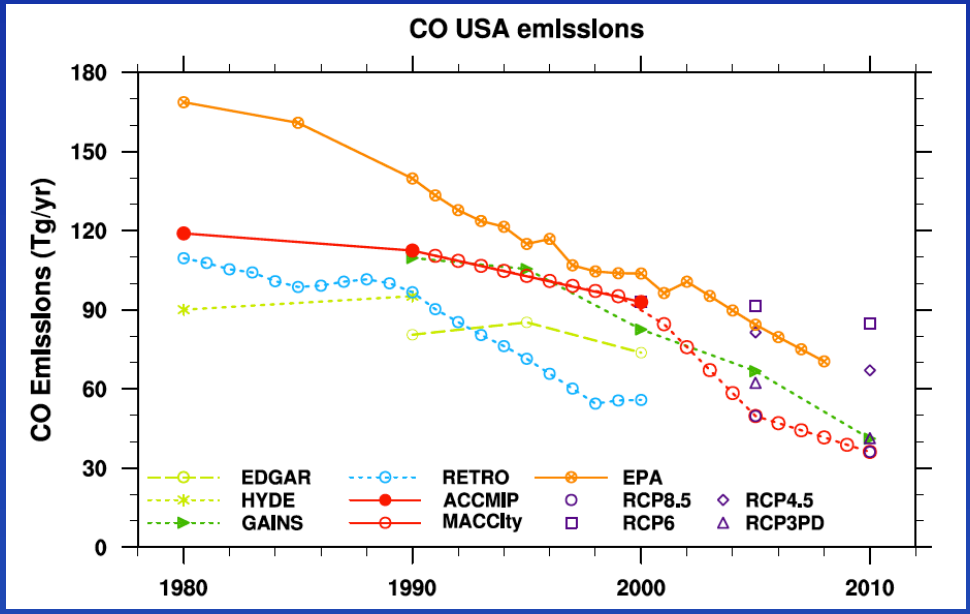


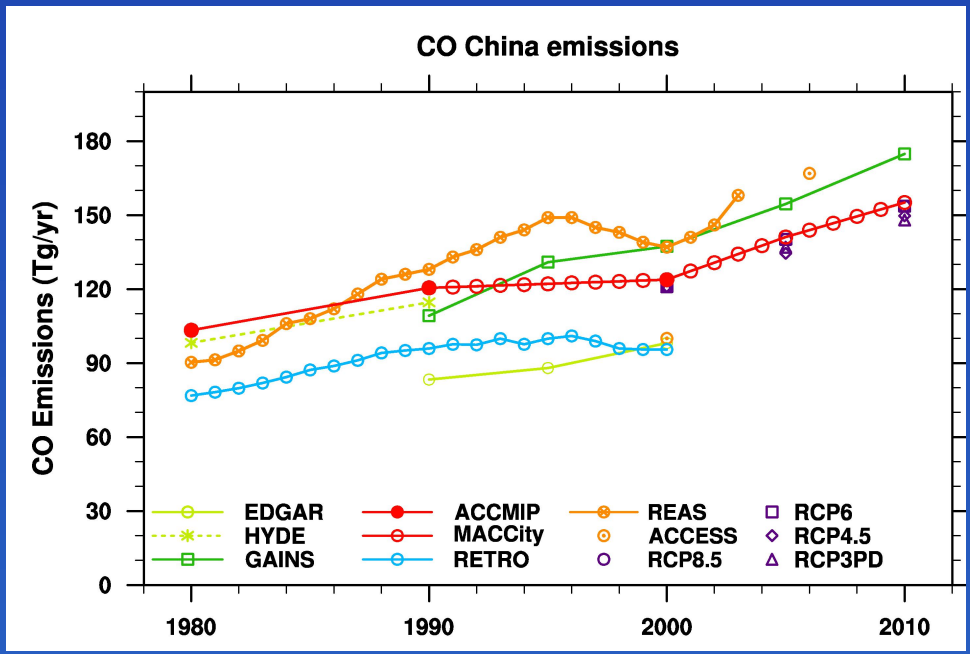


CO Western and Central Europe:

Global inventories

+ EMEP and TNO EU inventories





CO USA:

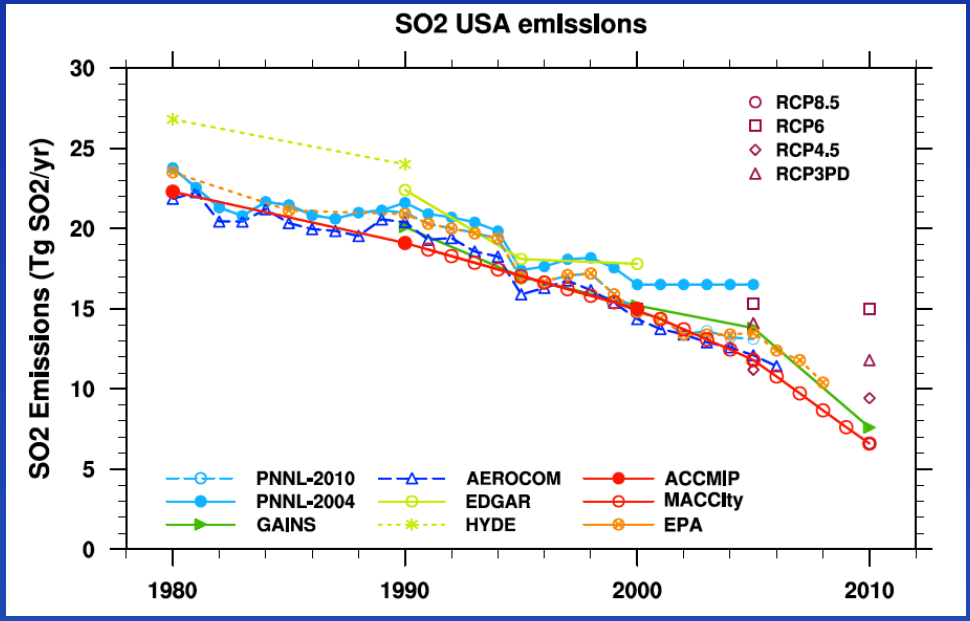
Global inventories

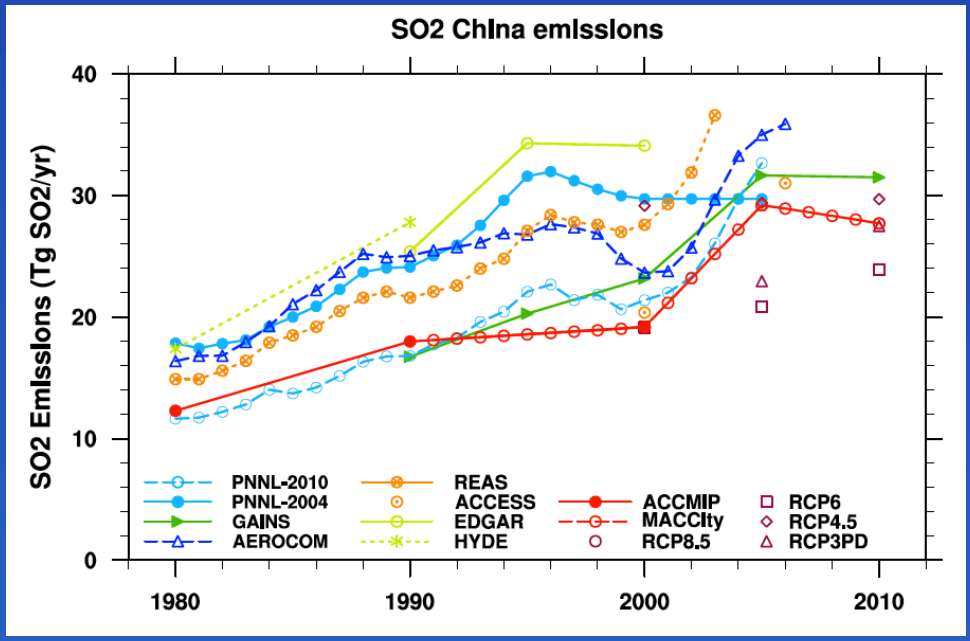
+ EPA US inventory

CO China:

Global and regional inventories

Examples of comparison of anthropogenic emissions





SO2 USA:

Global inventories

+ EPA US inventory

SO2 China:

Global inventories

+ REAS and ACCESS (Streets) regional inventories

Summmary: ratio between highest and lowest emissions

		1980	1990	2000	2005
BC					
	Total	1.53	1.61	1.27	1.27
	Western Europe	2.08	2.04	1.29	1.28
	Central Europe	2.45	2.81	2.21	1.40
	USA	2.38	2.77	1.61	1.59
	China	1.64	1.31	2.12	1.29
CO	Total	1.27	1.33	1.28	1.29
	Western Europe	1.34	1.55	1.77	1.30
	Central Europe	1.43	2.11	1.76	2.10
	USA	1.87	1.73	1.86	1.83
	China	1.34	1.54	1.43	1.17
NOx	Total	1.10	1.25	1.23	1.19
	Western Europe	1.14	1.18	1.20	1.18
	Central Europe	1.32	1.41	1.24	1.25
	USA	1.27	1.41	1.19	1.43
	China	1.91	1.66	1.31	1.42
SO2	Total	1.19	1.28	1.54	1.35
	Western Europe	1.25	1.49	2.35	2.35
	Central Europe	2.04	1.37	2.08	2.71
	USA	1.23	1.26	1.20	1.47
	China	1.45	1.66	1.87	1.68

Green:
1 to 1.25

Yellow:
1.25 to 1.5

Orange:
1.5 to 1.75

Grey:
Above 1.75

But: consensus among datasets does not mean emissions are correct

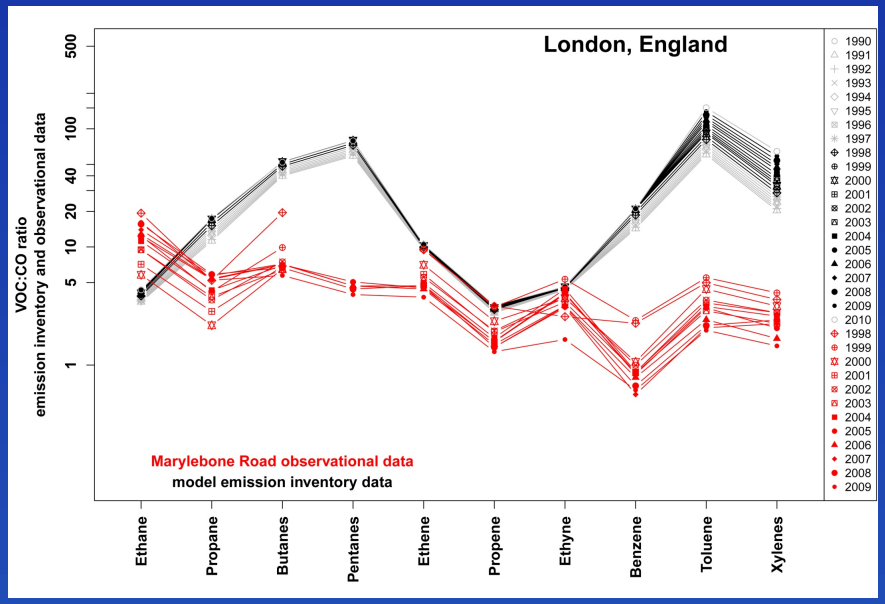
A few examples of uncertainties in emission inventories

→ Large diversity in space and time, difficult to quantify
→ Lack of information: non reported, not existing
→ Extrapolation errors when information is lacking
→ Measurement errors, for example for emission factors

→ several inventories are non-transparent about method and data
→ difficulties to compare data for sectors of different definitions
→ lack of different independent inventories
→ lack of measurement data and model studies to confront inventories with

More details in: Granier et al., Evolution of anthropogenic and biomass burning emissions of air pollutants at global and regional scales during the 1980-2010 period, Climatic Change, DOI 10.1007/s10584-011-0154-1, 2011.

Main issues the Emissions group in MACC-II will look at:



Issue 1: VOCs speciation

→ Only total VOCs reported in inventories

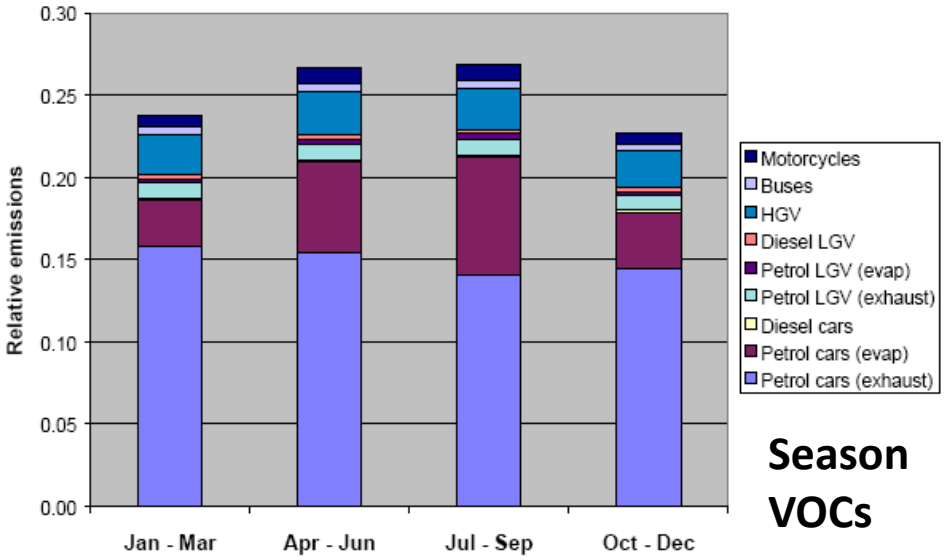
→ Atmospheric models need to know the detailed speciation on emissions

→ Models use their own speciation, but how accurate is it?

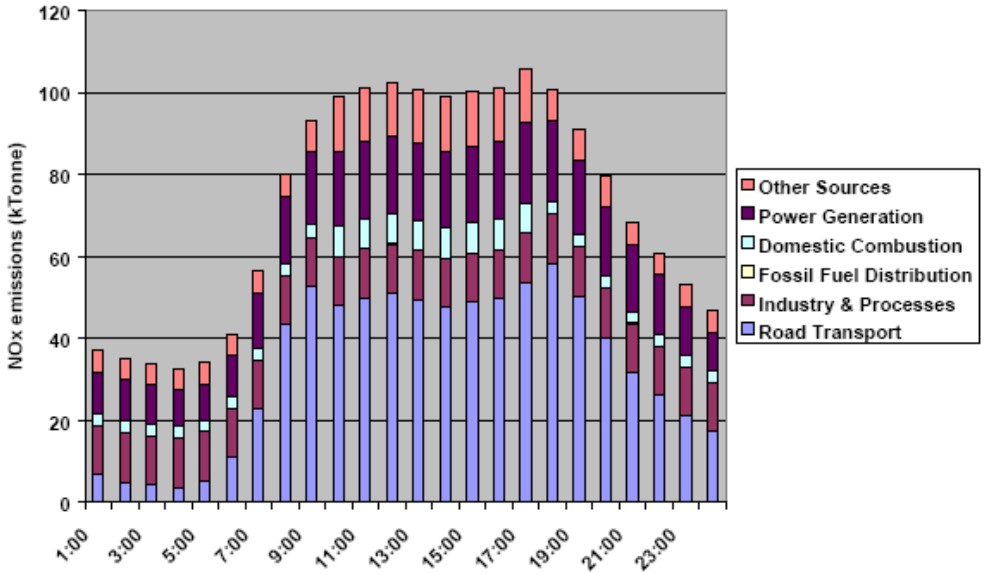
Work is currently being done to use observations of VOCs for defining a new speciation in inventories

Issue 2. Temporal variation

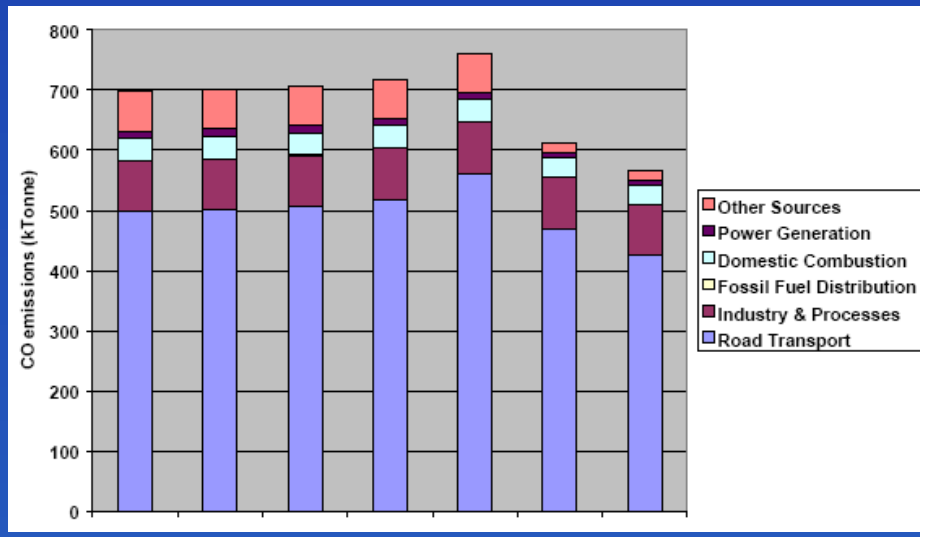
How to implement such temporal profiles?
detailed data only easily and freely available for a very few countries
Are there any recent data available?



Season VOCs

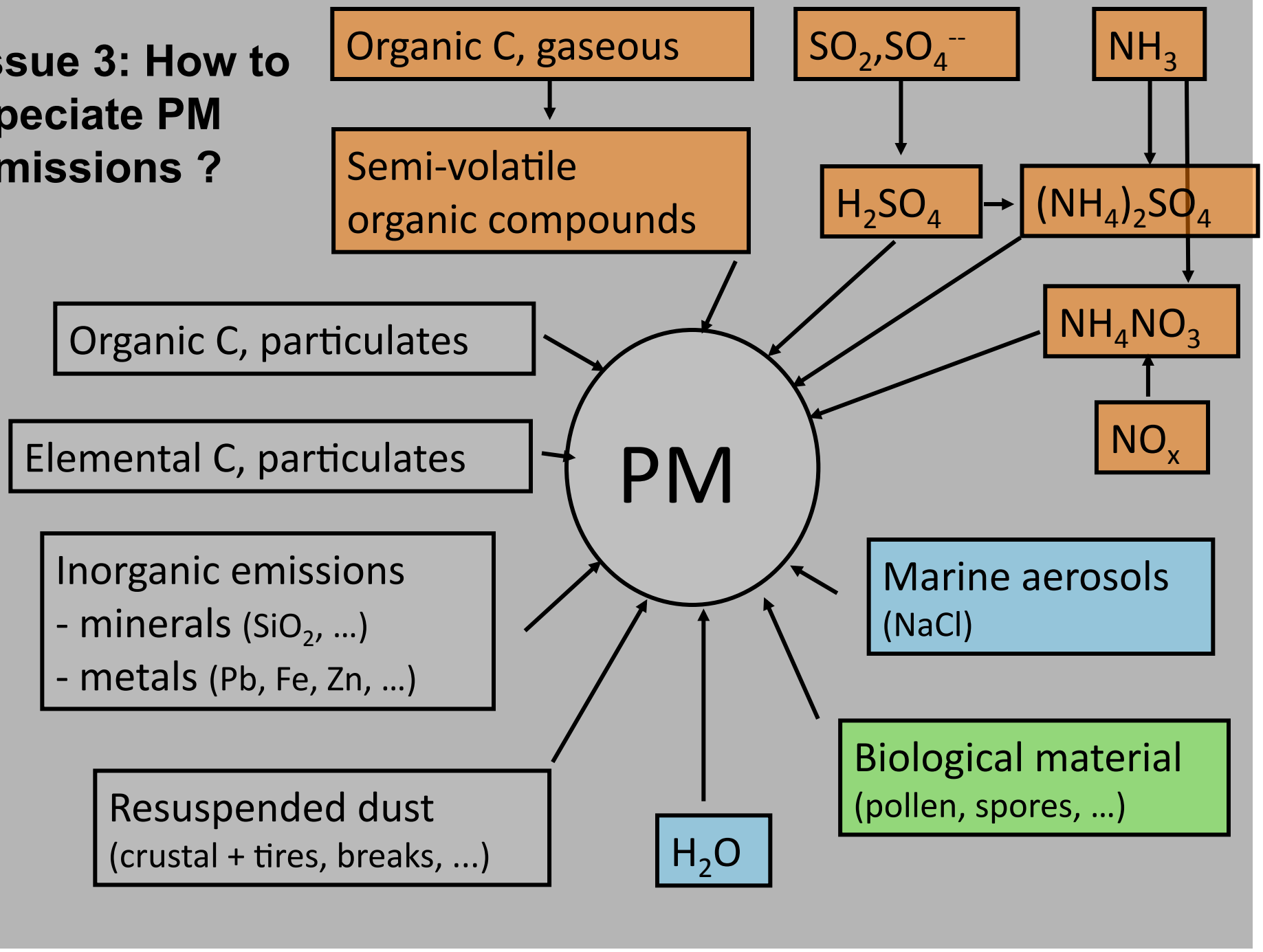


NOx diurnal emissions

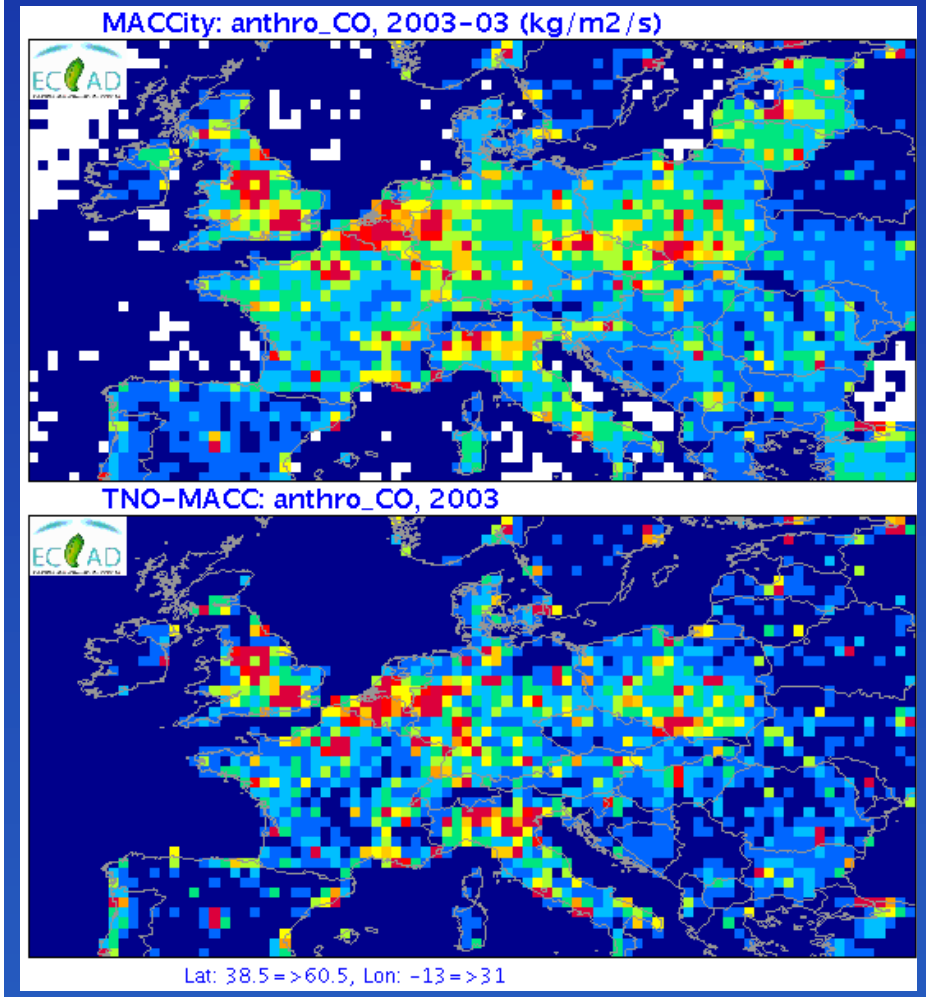


CO weekly emissions

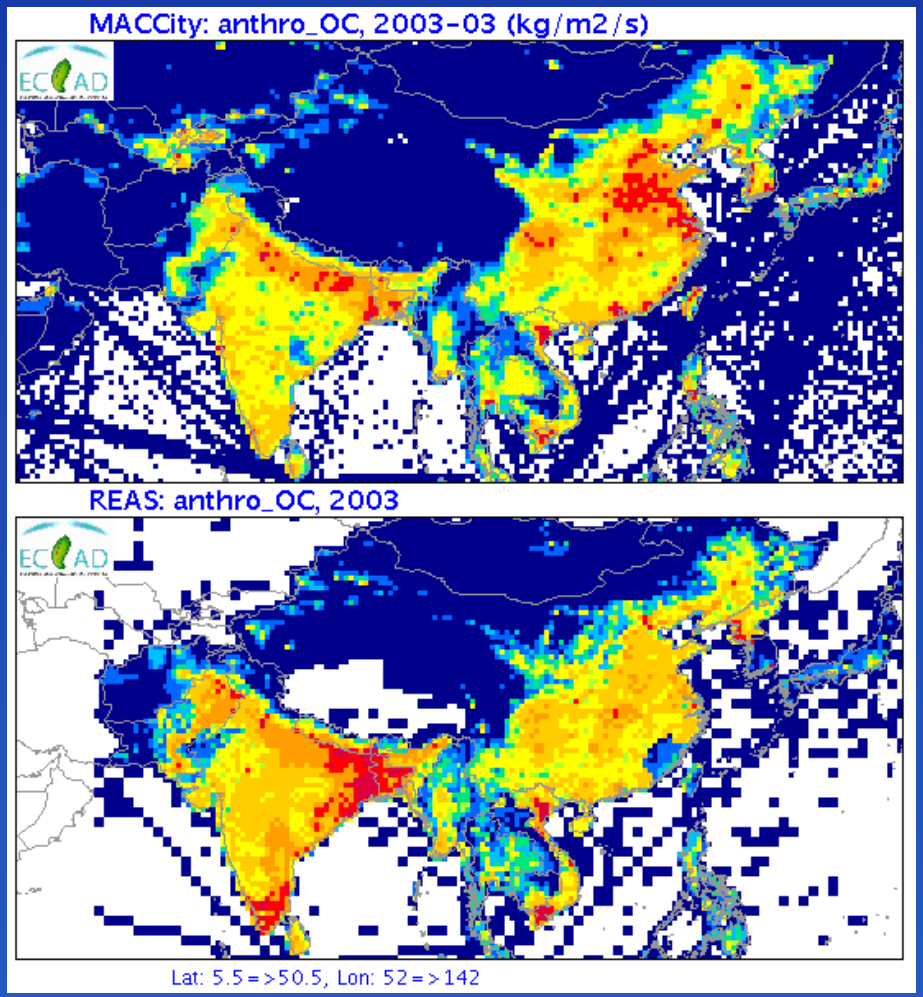
Issue 3: How to speciate PM emissions ?



Issue 4: Consistency between spatial distributions

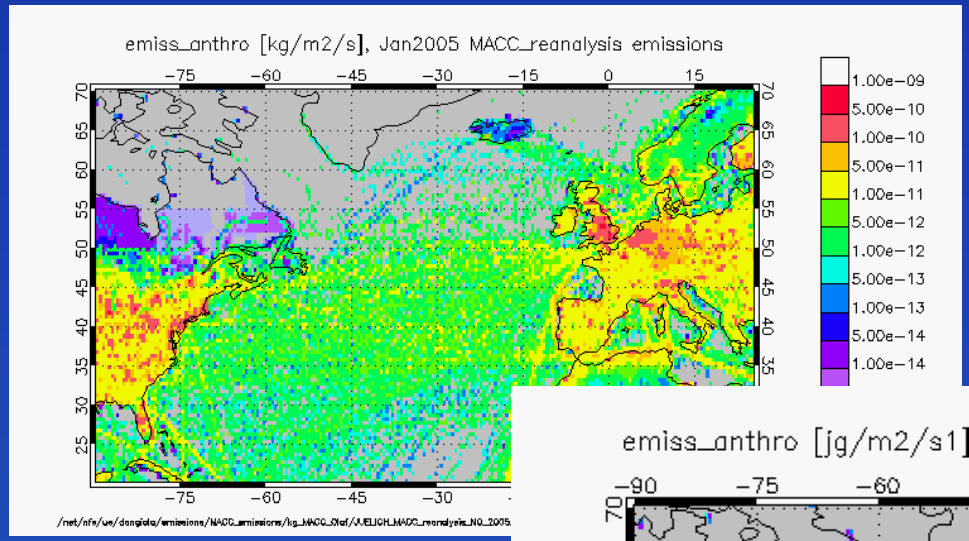


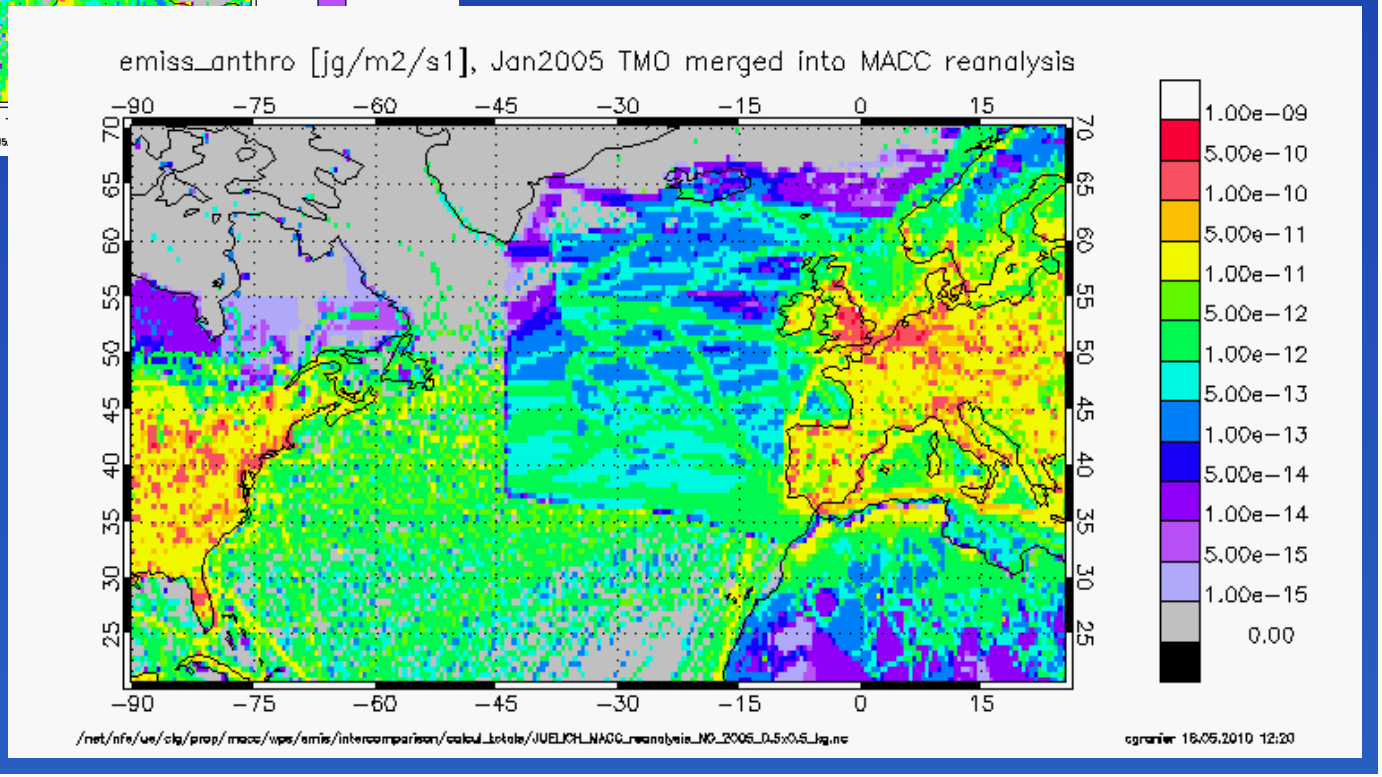
CO in Europe



OC in Asia

Issue 5: emissions from ships : very large inconsistencies

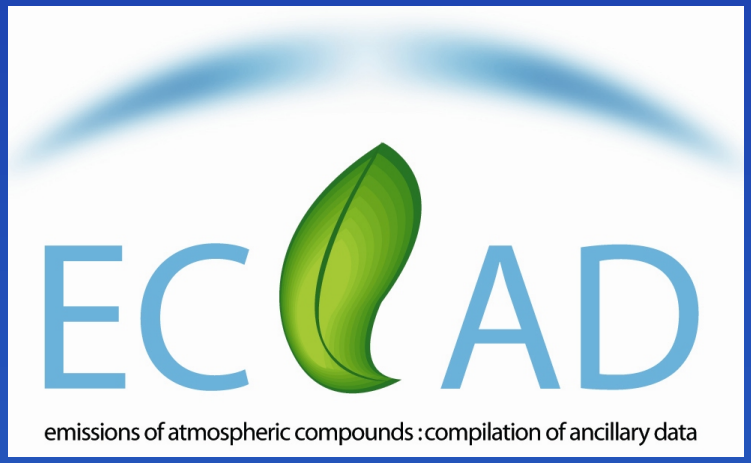




Where to find the emissions used in the intercomparison

- Most of them are available from the ECCAD database = Emissions of atmospheric Compounds & Compilation of Ancillary Data

http://eccad.sedoo.fr

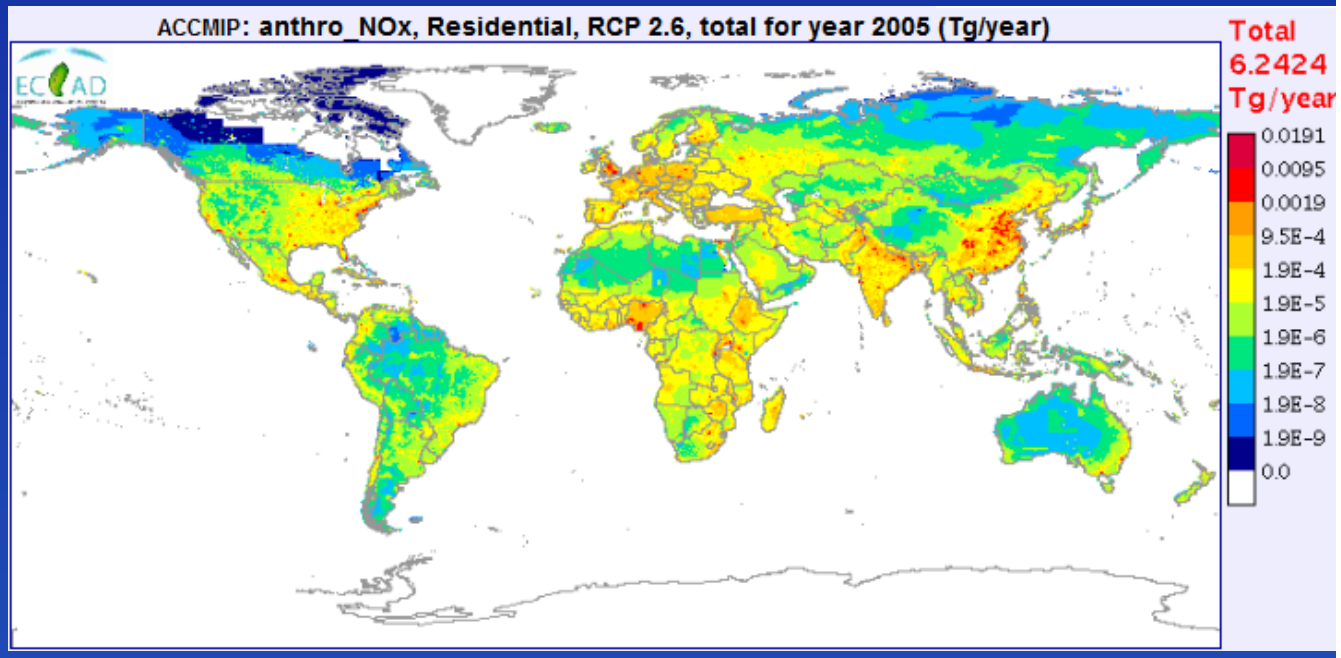


ECCAD is now the database of the GEIA (Gloabl Emissions Inventory Activity): geiacenter.org

ECCAD – Emissions Totals

Global

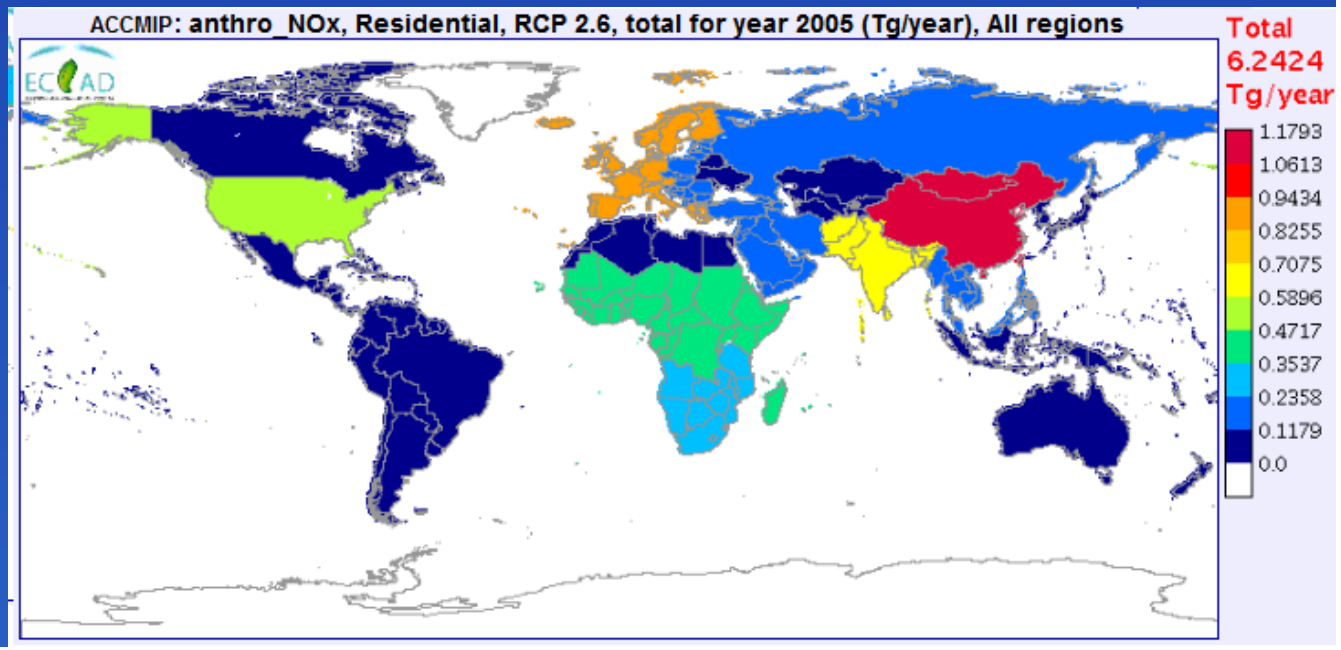
Total NOx, Residential, year 2005 : 6.24 Tg/year

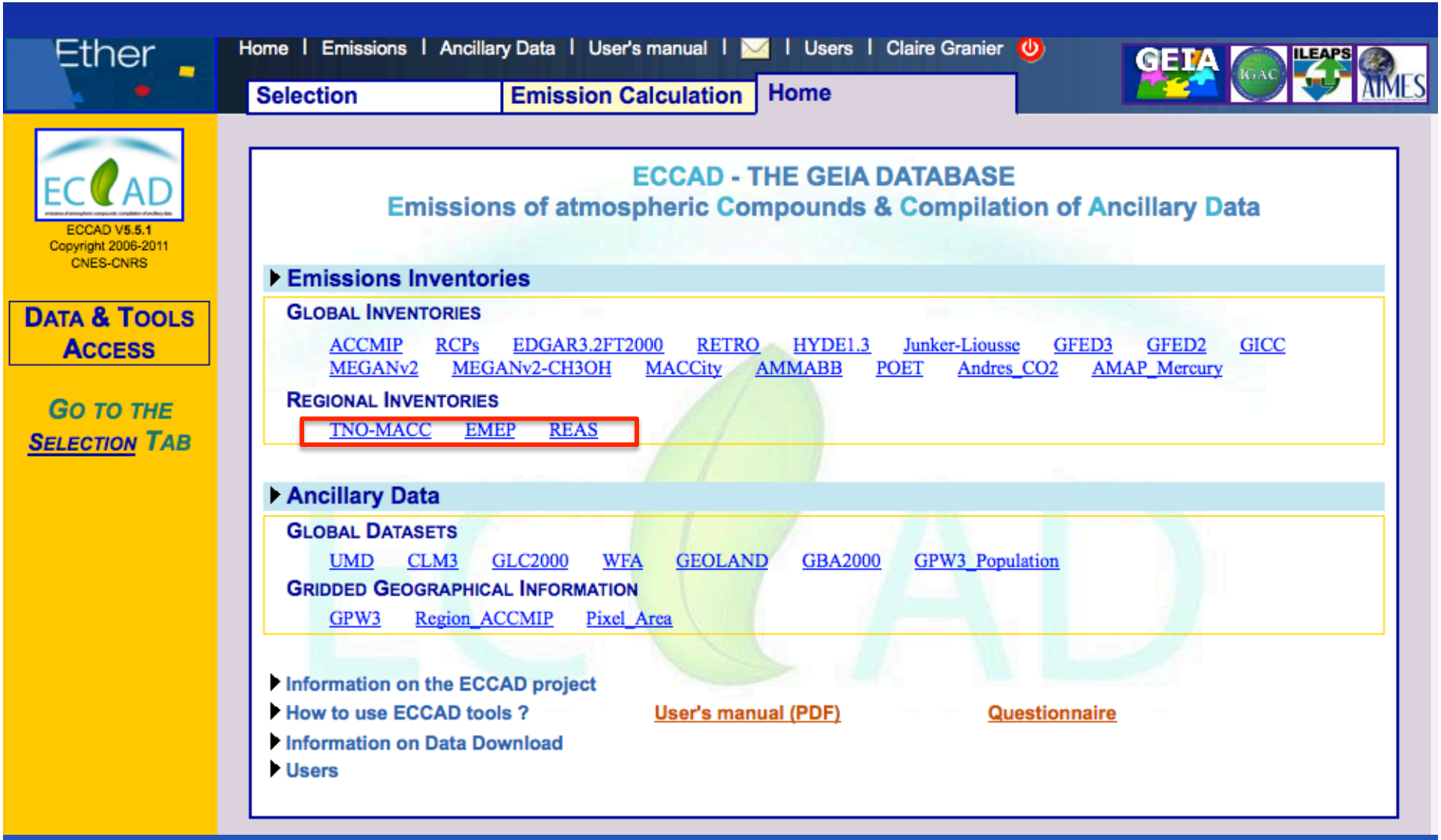


Totals for different regions

Total by regions : from 0.1 to 1.18 Tg/year

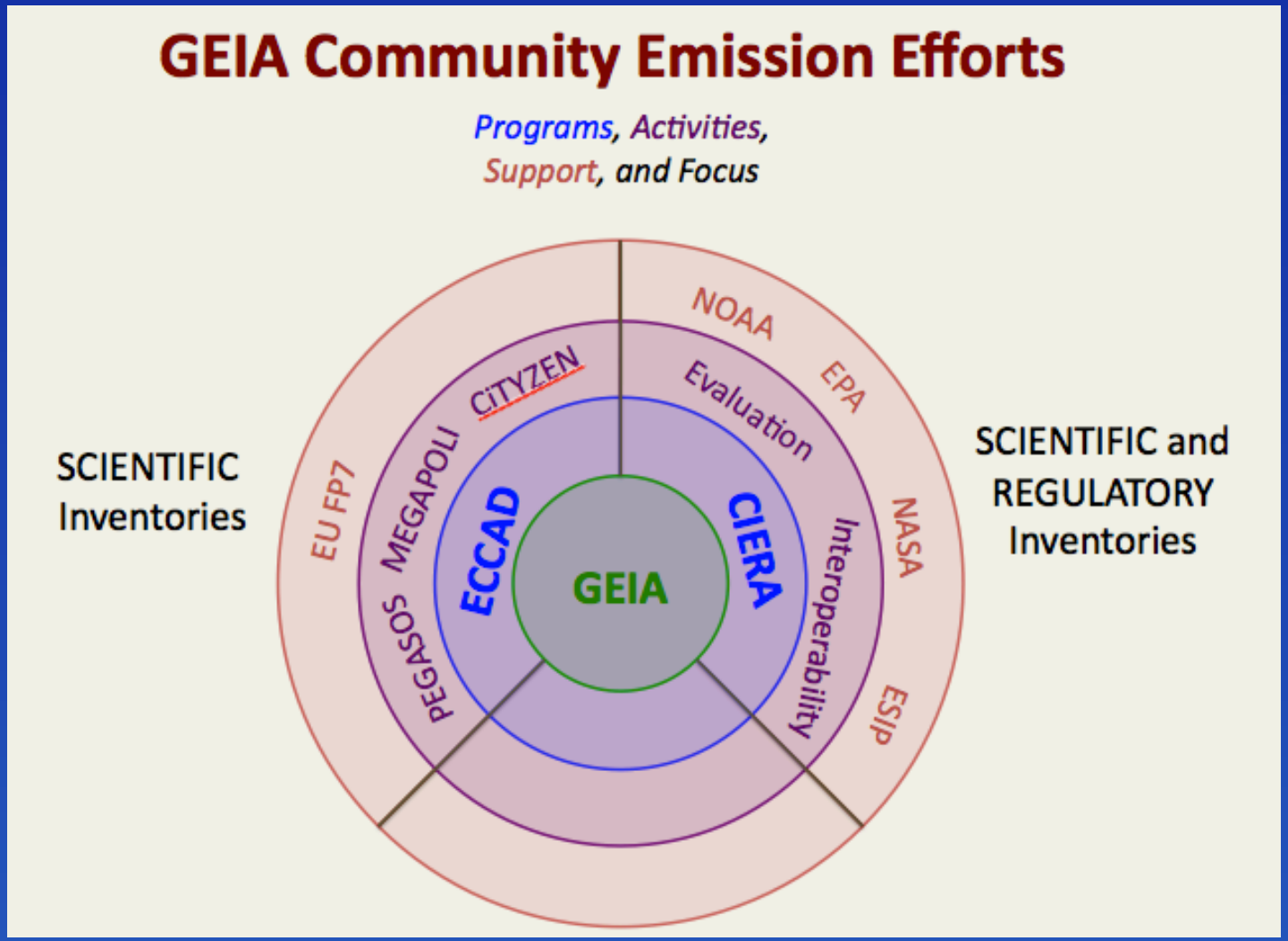
Output in excel/csv





ECCAD would be very interested in providing access to more regional data: inclusion of data for US and India in progress, more welcome

Any format is OK: the French/NOAA group will do all formatting work needed



From the Frost et al. Poster presented yesterday

More discussions: GEIA conference on Emissions to Address Science and Policy Needs; Toulouse France June 11-13, 2012

Thank you for your attention

CO emissions from different available global datasets for 2005